A REQUEST FOR INFORMATION FOR ADVANCED TURBINE TECHNOLOGIES AND DEVELOPMENT STRATEGIES TO ENABLE HIGH OVERALL PRESSURE RATIO (OPR), HIGH BYPASS RATIO (BPR) SMALL CORE PROPULSION SYSTEMS

The NASA Advanced Air Vehicles Program (AAVP) is developing tools and technologies to enable significant improvements in the noise, emissions, and performance of commercial transport aircraft with technical scope addressing airframe and propulsion technology challenges. This Request for Information (RFI) is focused on advanced propulsion systems and, more specifically, on turbine technologies for future high Overall Pressure Ratio (OPR), high By-Pass Ratio (BPR) small core turbofan engines. Information obtained from this RFI will help two AAVP projects, Advanced Air Transportation Technology (AATT) and Revolutionary Vertical Lift Technology (RVLT), make informed decisions on portfolio investments and potential acquisition strategies.

The AATT Project is pursuing advancements to both conventional and unconventional propulsion systems with an emphasis on longer term 2025 (N+3) solutions/goals for single-aisle transport aircraft (e.g., Boeing-737 class, Airbus-320 class). Primary goals of the AATT project are to reduce fuel burn by 60% and NOx emissions to 80% below the CAEP6 standard with minimal impact on noise and component life; similarly aggressive goals apply to the RVLT project. The engines of interest for the AATT application are characterized by higher (50+) overall pressure ratio (OPR) cycles, 20,000 to 30,000 pounds sea level static thrust, smaller cores (1.5-3.0 lbm/s compressor exit corrected flow), 1500F T3 capable disk rim and seals, and 3000F T4 capable turbine vanes and coatings.

The RVLT Project is focused on improving safety and fuel efficiency while reducing noise of the next generation rotorcraft aircraft. The engines of interest for the RVLT application are characterized by high OPR (~40+) cycles requiring compact axi-centrifugal compressors (~1.0 lbm/s or less compressor exit corrected flow), high compressor exit temperature (~1200F), and wide 50% variable speed low-pressure turbines.

While the AATT Project has established efforts in the areas of the high pressure compressors, hot section materials, and combustors, and the RVLT project has established efforts in high pressure ratio centrifugal compressors and variable speed power turbines, both projects seek external partnerships to address the aerothermal performance challenges of the N+3 high pressure turbine (HPT) for AATT and similar challenges for enabling a compact HPT for RVLT. The AATT and RVLT projects seek input from the Aeronautics community to define a comprehensive small core HPT

roadmap. From recent efforts, an initial list of HPT technical challenges is provided below.

- Mitigate losses associated with increased rotor tip clearance and seal cavity gaps and leakage/purge flows
- Minimize purge and cooling flows without adverse impact on turbine aero performance and durability
- Enable high inlet turbine temperatures with advanced materials and structural concepts, including ceramic composite blades, hybrid disks, and high temperature seals
- Enable advanced cooling concepts for metallic and/or ceramic composite blades for the HPT first-stage vane and rotor
- Enable rapid response control of high-pressure turbomachinery rotor blade tip clearance gaps
- Define additional HPT technical challenges for more electric vehicles
- Define technical challenges associated with combustor/turbine interactions (e.g., combustor pattern factor impact on HPT performance)

The NASA projects are specifically requesting responses to the following topics/questions:

(1) Recommendations of technologies to enable the N+3 turbine for AATT and the compact high pressure ratio HPT to enable RVLT compact gas generator. Recommendations should include a statement on the specific technical problem being addressed, expected benefits with respect to the AATT and RVLT projects' goals, prioritization of recommended technologies, and comparison to current state of the art for AATT and RVLT high pressure ratio HPT's. For each HPT technology, please provide a recommended roadmap with yearly ROM costs and TRL progression to achieve TRL 4/5 demonstration. NASA TRL (Technology Readiness Level) descriptions and definitions can be found at http://www.nasa.gov/content/technology-readiness-level and http://esto.nasa.gov/files/trl_definitions.pdf.

(2) Comments on the following potential approaches to conduct turbine component level (TRL 4/5) tests and evaluations of the advanced HPT technologies: a) establish an "open" and adaptable geometry state-of-the-art turbine test article with key features that can be reconfigured for testing generic/open or proprietary geometries, b) design and fabricate a specific turbine concept incorporating the company's proposed advanced technologies to achieve the N+3 goals, and/or c) provide another approach. NASA seeks input on the advantages and disadvantages of each

approach. NASA requests comments on the level of cost sharing and the proprietary nature of each approach. NASA also requests estimated ROM costs and schedule (e.g., design, fab timeframes) to complete the aero and structural design and build of the turbine test article.

(3) Recommendations, including advantages and disadvantages, of candidate test facilities for the turbine component level (TRL 4/5) tests required to evaluate the advanced technologies and approaches proposed in response to questions #1 and #2. NASA seeks comments specifically on, but not limited to, candidate test facilities suitable for “open” geometry turbine testing. Respondents can recommend multiple facility/approaches for each particular technology concept/approaches identified in question #1, if deemed advantageous.

The information package response shall address the topics and specific questions posed herewith. Interested parties are also requested to provide the following: Name and address of organization and point of contact (POC) information (name, phone, and e-mail). Responses and RFI questions should be submitted to Kenneth.L.Suder@nasa.gov, with a copy going to James.F.Walker@nasa.gov. Submissions may be sent via encrypted e-mail (PKI) (recommended if proprietary information is included). If so requested in your response, all information received from this RFI will be considered confidential and proprietary. Proprietary and export controlled information should be marked appropriately in your response to the RFI. Questions regarding this RFI must be submitted no later than June 5 and the RFI response must be submitted not later than July 3, 2015.

Respondents are advised that NASA is under no obligation to acknowledge receipt of the information received or to provide feedback to respondents with respect to any information submitted under this RFI. NASA may contact respondents if clarification or additional information is desired. No solicitation exists; therefore, do not request a copy of one. This pre-solicitation synopsis is not to be construed as a commitment by the Government, nor will the Government pay for the information submitted in a response. As stipulated in FAR 15.201(e), responses to this notice are not considered offers, shall not be used as a proposal, and cannot be accepted by the government to form a binding contract. Submittals shall be compliant with all legal and regulatory requirements concerning limitations on export controlled items. Respondents will not be notified of the results. It is the respondent's responsibility to monitor FedBizOpps.gov for the release of the solicitation and amendments (if any).